

MIT LINCOLN LABORATORY

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MIT Lincoln Laboratory's fundamental mission is to apply science and advanced technology to critical problems of national security. To assure excellence in the fulfillment of this mission, the Laboratory is committed to fostering an environment that embraces and leverages diversity of thought, culture, and experience.

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## Quick Facts

MIT Lincoln Laboratory is a Department of Defense federally funded research and development center.

### Established

1951

### Research areas

Sensors, data extraction (signal processing and embedded computing), communications, integrated sensing and decision support, advanced electronics, cyber security

### Major sponsors

U.S. Air Force, U.S. Army, U.S. Navy, Missile Defense Agency, Defense Advanced Research Projects Agency, Office of the Secretary of Defense, NASA, Federal Aviation Administration

### Director

Dr. Eric D. Evans

### Personnel

1765 professional technical staff; 447 technical support staff; 1523 support staff; 528 technical and technical support subcontractors; 4263 total personnel

### Facility profile

*28 buildings and structures*—a total area of 2.1 million sq ft

*Located on 3 sites*—main facility in Lexington, Mass.; Flight and Antenna Test Facility on Hanscom Air Force Base in Bedford, Mass.; Millstone Hill radar complex in Westford, Mass.

*Field Sites:* 3

*Field Offices:* 8

### U.S. patents issued to Lincoln Laboratory technical staff since 1951

780

### Spin-off companies since 1951

98



## Overview

MIT Lincoln Laboratory is a Department of Defense (DoD) federally funded research and development center working on problems critical to national security. The Laboratory's core competencies are in sensors, information extraction (signal processing and embedded computing), communications, cyber security, integrated sensing, and decision support.

Technology development is geared to the Laboratory's primary mission areas—space control; air and missile defense; communication systems; intelligence, surveillance, and reconnaissance systems; advanced electronics; tactical systems; homeland protection; cyber security; and air traffic control.

Two of the Laboratory's principal technical objectives are (1) the development of components and systems for experiments, engineering measurements, and tests under field operating conditions and (2) the dissemination of information to the government, academia, and industry.

Program activities extend from fundamental investigations through the design process and finally to field demonstrations of prototype systems. Emphasis is placed on transitioning systems and technology to industry.

As a DoD Research and Development Laboratory, Lincoln Laboratory focuses on developing and prototyping innovative technologies and enhanced capabilities to meet the evolving needs of the DoD.

Lincoln Laboratory also undertakes government-sponsored, nondefense projects in areas such as the development of systems the Federal Aviation Administration relies on to improve air traffic control and air safety, and systems that the National Oceanic and Atmospheric Administration uses in weather surveillance.

### **What is an FFRDC?**

A federally funded research and development center (FFRDC) is an independent, nonprofit entity sponsored and supported by the U.S. government to develop concepts and technologies to meet evolving long-term, and occasionally high-priority short-term, needs that cannot be met as effectively by government or contractor resources. An FFRDC conducts scientific research and analysis, prototype development, and system assessments to provide novel, cost-effective solutions to complex government problems. To ensure objectivity and foster technical excellence, an FFRDC is contractually prohibited from manufacturing products, competing with industry, or working for commercial companies.

All FFRDCs are sponsored by government departments or agencies with whom they work as strategic partners, but they are privately administered by universities and other nonprofit organizations. A strength of FFRDCs is that they draw on the expertise and perspective of government, industry, and academia. Currently 39 FFRDCs work in the fields of defense, energy, aviation, space, health and human services, and tax administration. Lincoln Laboratory is one of nine Department of Defense FFRDCs.

### **Historical Brief**

Lincoln Laboratory was established in 1951 to develop an air defense system for the United States. The Laboratory's first building was completed in 1952 and four more buildings were completed by 1954. Today, the complex, located



primarily on Hanscom Air Force Base in Massachusetts, comprises 28 facilities, including a state-of-the-art Microelectronics Laboratory.

The first project of Lincoln Laboratory was the Semi-Automatic Ground Environment (SAGE) air defense system, which was developed to collect, analyze, and relay data from multiple radars quickly enough to initiate a response if an air attack were identified. The Whirlwind computer built at MIT was at the heart of this system; the Laboratory's second-generation Whirlwind enabled transmittal and interpretation of enormous amounts of data—virtually in real time. SAGE was the beginning of the Laboratory's long history of developing innovative technology.

In 2001, Lincoln Laboratory received the Secretary of Defense Medal for Outstanding Public Service in recognition of a half-century of technical innovation and scientific discoveries.

*To learn more about Lincoln Laboratory's history, visit the web at <http://www.ll.mit.edu/about/History/history.html>.*

## **Directors of Lincoln Laboratory**

- 11 Eric D. Evans** 1 July 2006–present
- 10 David L. Briggs** 1 July 1998–30 June 2006
- 9 Walter E. Morrow** 1 April 1977–30 June 1998
- 8 Gerald P. Dinneen** 1 June 1970–1 April 1977
- 7 Milton U. Clauser** 1 January 1967–1 June 1970
- 6 C. Robert Wieser (Acting)** 10 May 1966–1 January 1967
- 5 William H. Radford** 1 February 1964–9 May 1966
- 4 Carl F.J. Overhage** 1 February 1957–1 February 1964
- 3 Marshall G. Holloway** 5 May 1955–1 February 1957
- 2 Albert G. Hill** 9 July 1952–5 May 1955
- 1 F. Wheeler Loomis** 26 July 1951–9 July 1952

## Lincoln Laboratory Logo



The Lincoln Laboratory logo is a Lissajous figure enclosed in a rectangle formed by two L's rotated 180° with respect to each other. The Lissajous figure, also known as Bowditch curves,

is based on the superposition of two harmonic vibrations and symbolizes order and stability.

## Seven Decades of Technical Achievements

### 1950s

- Ballistic Missile Early Warning System
- Distant Early Warning Line
- Millstone Hill Radar / Space Surveillance
- Semi-Automatic Ground Environment (SAGE) System
- Whirlwind computer magnetic-core memory and subsequent models—Whirlwind II and the AN/FSQs

### 1960s

- First satellite television transmission
- Gallium arsenide semiconductor laser demonstration
- Haystack Radar operations
- Lincoln Experimental Satellites 1 to 6
- Lunar mapping for Apollo landing
- Lunar range-Doppler mapping

### 1970s

- Air Traffic Control program / Mode S airport surveillance
- Air vehicle survivability programs
- ARPA-Lincoln C-band Observables Radar and TRADEX Radar S-band upgrade, Kwajalein Atoll
- Extremely high-frequency submarine communications demonstration
- Continuous-wave diode laser developed in InGaAsP/InP alloy
- Ground-based Electro-Optical Deep Space Surveillance system at Experimental Test Site in New Mexico
- Lincoln Experimental Satellites 8 and 9

## 1980s

- Airborne Seeker Test Bed
- Airborne towed countermeasures
- Charge-coupled device for Short-Wavelength Adaptive Techniques program
- Cobra Judy X-band system
- Compact linear-predictive coding vocoder
- Kwajalein / Lexington Discrimination System
- Millimeter Wave Radar, Kwajalein Atoll

## 1990s

- Biological Agent Warning Sensor
- Chandra Observatory charge-coupled device camera
- Cobra Gemini
- Earth Orbiting (EO)-1 Advanced Landsat Imager
- Firepond laser radar imaging demonstration
- Fly-Along Sensor Package
- Kwajalein Modernization and Remoting program
- Lincoln Near-Earth Asteroid Research (LINEAR) program
- Microelectronics Laboratory operational
- Space-Based Visible payload
- Terminal Doppler Weather Radar deployment
- Theater Critical Measurements Program flight tests
- Traffic Alert and Collision Avoidance (TCAS) system

## 2000s

- Airborne Ladar Imaging Research Testbed
- Airport Surveillance Radar / Weather Systems Processor
- CANARY / PANTHER pathogen-detection sensors
- Decision support architectures
- Enhanced Regional Situation Awareness system
- Geosynchronous Lightweight Integrated Technology Experiment
- Jigsaw 3D imaging laser radar
- LLGrid cluster computing
- NASA Earth Observation-1

- Nonlinear equalization for receiver dynamic range extension
- Orthogonal transfer arrays for wide-field camera
- Runway Status Lights system
- Slab-coupled optical waveguide laser
- Wideband Global SATCOM system

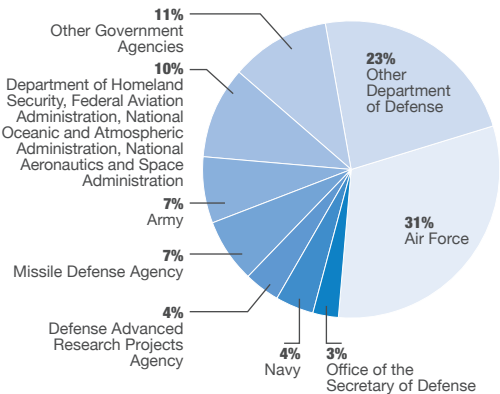
## 2010s

- Airborne Collision Avoidance System X
- Cryptographic key management architectures
- Cyber security technologies
- Digital-pixel focal plane arrays
- Geiger-mode avalanche photodiode focal plane arrays
- Graph detection algorithms
- Graphene-on-insulator electronics
- Ground-penetrating radar
- Haystack Ultrawideband Satellite Imaging Radar
- Lincoln Adaptable Real-time Information Assurance Testbed
- Lunar Laser Communications Demonstration
- Millimeter Wave Radar upgrade
- Miniaturized radio-frequency receiver
- Missile Alternative Range Target Instrument payloads
- Multifunction phased array radar panels
- Next-Generation Incident Command System
- Reagan Test Site Distributed Operations
- Space Surveillance Telescope
- Wide-area chemical sensing
- Wide-area persistent surveillance systems
- X-band Transportable Radar

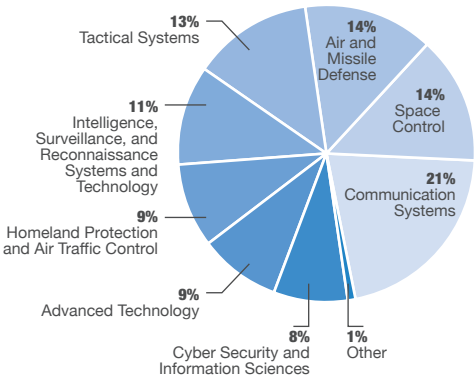
# Funding

Lincoln Laboratory programs are funded by a number of DoD agencies through its prime contract with the Air Force.

Breakdown of Program Funding by Sponsor



Breakdown of Program Funding by Mission Area





## **Mission Areas and Research**

### **Mission Areas**

#### **Space Control**

Lincoln Laboratory develops technology that enables the nation's space surveillance system to meet the challenges of space situational awareness. The Laboratory works with systems to detect, track, and identify man-made satellites; collects orbital-debris detection data to support space-flight safety; performs satellite mission and payload assessment; and investigates technology to improve monitoring of the space environment, including space weather and atmospheric and ionospheric effects. The technology emphasis is the application of new components and algorithms to enable sensors with greatly enhanced capabilities and to support the development of netcentric processing systems for the nation's Space Surveillance Network.

#### **Air and Missile Defense Technology**

Lincoln Laboratory develops and assesses integrated systems for defense against ballistic missiles, cruise missiles, and air vehicles in tactical, regional, and homeland defense applications. Activities include the investigation of system architectures, development of advanced sensor and decision support technologies, development of flight-test hardware, extensive field measurements and data analysis, and the verification and assessment of deployed system capabilities. A strong emphasis is on rapidly prototyping sensor and system concepts and algorithms, and on transferring resulting technologies to government contractors responsible for developing operational systems.

## **Communication Systems**

Lincoln Laboratory works to enhance and protect the capabilities of the nation's global defense networks. Emphasis is placed on synthesizing communication system architectures, developing component technologies, building and demonstrating end-to-end system prototypes, and then transferring this technology to industry for deployment in operational systems. Current efforts focus on radio-frequency (RF) military satellite communications, free-space laser communications, tactical network radios, quantum systems, and spectrum operations.

## **Cyber Security and Information Sciences**

Lincoln Laboratory conducts research, development, evaluation, and deployment of cyber-resilient components and systems designed to ensure that national security missions can be accomplished successfully despite cyber attacks. Efforts include cyber analysis; architecture engineering; development and assessment of prototypes that demonstrate the practicality and value of new cyber protection, detection, and reaction techniques; and, where appropriate, deployment of prototype technology into operations. The Laboratory plays a major role in the design, development, and operation of large-scale cyber ranges and cyber exercises. The Laboratory also develops advanced hardware, software, and algorithms for processing large, high-dimensional datasets from a wide range of sources, including speech, imagery, text, and network traffic. Emphasis is placed on high-performance computing architectures, machine learning for advanced analytics, and the use of relevant metrics and realistic datasets.

## **ISR Systems and Technology**

To expand intelligence, surveillance, and reconnaissance (ISR) capabilities, Lincoln Laboratory conducts research and development in advanced sensing, signal and image processing, automatic target classification, decision support,

and high-performance computing. By leveraging these disciplines, the Laboratory produces novel ISR system concepts for both surface and undersea surveillance applications. Sensor technology for ISR includes passive and active electro-optical systems, surface surveillance radar, RF geolocation, and undersea acoustic surveillance. Increasingly, the work extends from sensors and sensor platforms to include the processing, exploitation, and dissemination technologies that transform sensor data into the information and situational awareness needed by operational users. Prototype ISR systems developed from successful concepts are then transitioned to industry and the user community.

### **Tactical Systems**

Lincoln Laboratory assists the Department of Defense (DoD) in improving the development and employment of various tactical air and counterterrorism systems through a range of activities that includes systems analysis to assess technology impact on operationally relevant scenarios, detailed and realistic instrumented tests, and rapid prototype development of U.S. and representative threat systems. A tight coupling between the Laboratory's efforts and DoD sponsors and warfighters ensures that these analyses and prototype systems are relevant and beneficial to the warfighter.

### **Advanced Technology**

Lincoln Laboratory's Advanced Technology mission supports national security by identifying new phenomenology that can be exploited in novel system applications and by then developing revolutionary advances in subsystem and component technologies that enable key, new system capabilities. These goals are accomplished by a community of dedicated employees with deep technical expertise, collectively knowledgeable across a wide range of relevant disciplines and working in unique, world-class facilities. This highly multidisciplinary work leverages solid-state



electronic and electro-optical technologies, innovative chemistry, materials science, advanced RF technology, and quantum information science.

### **Homeland Protection**

The focuses of the Homeland Protection mission area are to support the nation's security by innovating technology and architectures to help prevent terrorist attacks within the United States, to reduce the vulnerability of the nation to terrorism, to minimize the damage from terrorist attacks, and to facilitate recovery from either man-made or natural disasters. The broad sponsorship for this mission area spans the DoD, the Department of Homeland Security (DHS), and other federal, state, and local entities. Recent efforts include architecture studies for the defense of civilians and facilities, new microfluidic technologies for DNA assembly and transformation and for gene synthesis, improvement of the Enhanced Regional Situation Awareness system for the National Capital Region, the assessment of technologies for border and maritime security, and the development of architectures and systems for disaster response.

### **Air Traffic Control**

Since 1971, Lincoln Laboratory has supported the Federal Aviation Administration (FAA) in the development of new technology for air traffic control. This work initially focused on aircraft surveillance and weather sensing, collision avoidance, and air-ground data link communication. The program has evolved to include safety applications, decision support services, and air traffic management automation tools. The current program is supporting the FAA's Next Generation Air Transportation System (NextGen). Key activities include the development of the next-generation airborne collision avoidance system; the refinement and technology transfer of NextGen weather architectures, including cloud-processing and net-centric

data distribution; and the development of standards and technology supporting unmanned aerial systems' integration into civil airspace.

## Engineering

Fundamental to the success of Lincoln Laboratory is the ability to build hardware systems incorporating advanced technology. These systems are used as platforms for testing new concepts, as prototypes for demonstrating new capabilities, and as operational systems for addressing warfighter needs. To construct the variety of systems used in programs across all mission areas, the Laboratory relies on its extensive capabilities in mechanical design and analysis, optical system design and analysis, aerodynamic analysis, mechanical fabrication, electronics design and assembly, autonomous and control system development, system integration, and environmental testing. These capabilities are centered in the Laboratory's Engineering Division, which is an important contributor to many of the Laboratory's most successful efforts.

*For more about the Laboratory's mission areas, visit the web at <http://www.ll.mit.edu/mission/index.html>.*

## Major Capabilities of Lincoln Laboratory

- Adaptive signal processing
- Advanced imaging
- Advanced microelectronics and microsystems
- Advanced radar technology
- Advanced RF technology
- Biological/chemical agent detection and identification
- Communication systems
- Cyber security
- Decision support technologies
- Environmental monitoring
- High-performance computing
- Homeland protection systems
- Human language technologies
- Laser communications

- Net-centric architectures
- Open systems architectures
- Optics and laser systems
- Rapid prototyping
- Space situational awareness
- Systems analysis
- Threat assessment
- Weather sensing

## **Research Initiatives**

Internal research and development at Lincoln Laboratory are supported through a congressionally appropriated source of funding that is administered by the office of the Assistant Secretary of Defense for Research and Engineering. This funding supports the long-term strategic technology capabilities of existing and envisioned mission areas. Research projects focus on addressing technology gaps in critical problems facing national security.

This funding fosters innovative research that often leads to further sponsored program development. It supports mission-specific research needs and the development of new initiatives. In addition, this funding finances a limited portfolio of collaborative academic research with universities. Through these collaborations, the Laboratory gains access to emerging, cutting-edge research pertinent to mission-area needs, and university students have the opportunity to work on timely and relevant problems.

In 2014–2015, the Laboratory is funding novel work in optical systems and technology; cyber security; information, computation, and exploitation; RF systems and technology; quantum system sciences; novel and engineered materials; biomedical sciences; and autonomous systems. These technology areas provide critical capabilities that support all the DoD mission areas pursued at the Laboratory and address difficult emerging problems.



## Organization

Lincoln Laboratory is led by the Director, Associate Director, and Assistant Director for Operations in conjunction with a Steering Committee consisting of the Director's Office and the heads of the technical divisions. The Laboratory reports to the MIT Office of the President. An annual review of Lincoln Laboratory is conducted by a Joint Advisory Committee composed of the Laboratory's major sponsors and led by the Assistant Secretary of Defense for Research and Engineering.

Lincoln Laboratory's eight technical divisions contain work-specific groups. Projects within the ten core mission areas are often multidisciplinary, involving interdivisional collaborations. The technical work of the Laboratory is supported by six service departments.

### Technical Divisions

Division 3—Air and Missile Defense Technology

Division 4—Homeland Protection and Air Traffic Control

Division 5—Cyber Security and Information Sciences

Division 6—Communication Systems

Division 7—Engineering

Division 8—Advanced Technology

Division 9—Aerospace

Division 10—Intelligence, Surveillance, and Reconnaissance  
and Tactical Systems

### Service Departments

Contracting Services, Facility Services, Financial Services,  
Human Resources, Information Services, Security Services



## Working at Lincoln Laboratory

Lincoln Laboratory's reputation has been built on the strength and quality of its technical staff. Approximately 1720 professional technical staff members work on research, prototype building, and field demonstrations. The technical staff come from a broad range of scientific and engineering fields. Two-thirds of this professional staff hold advanced degrees.

The Laboratory also employs about the same number of people to provide the strong infrastructure and administrative functions that support the research and demonstration activities behind the development of new devices and technologies.

### Technical Positions

Lincoln Laboratory technical staff members come from many scientific and engineering fields; electrical engineering, physics, and computer science are three of the most common disciplines represented at the Laboratory.

Positions filled by engineers and scientists at Lincoln Laboratory require problem-solving ability, analytical skills, and creativity.

### Representative Technical Positions

- Aerospace engineer
- Applications engineer
- Bioengineer
- Biologist

- Communications systems engineer
- Computer scientist
- Cyber security analyst
- Data analyst
- Data fusion engineer/scientist
- Electro-optical device developer
- Electro-optical systems developer
- Electronics hardware engineer
- Integrated circuit architect/designer
- Laser applications engineer
- Mechanical/Optomechanical engineer
- Meteorologist
- Mission assurance engineer
- Network engineer
- Optical image analyst
- Optical system designer
- Radar systems analyst
- Radar systems engineer
- RF engineer
- Scientific programmer
- Signal processing engineer/analyst
- Software developer/programmer
- Software engineer
- Systems analyst
- Systems engineer
- System integrator and test engineer

*For information on available positions at Lincoln Laboratory, visit the web at <http://www.ll.mit.edu/employment/jobs.html>.*

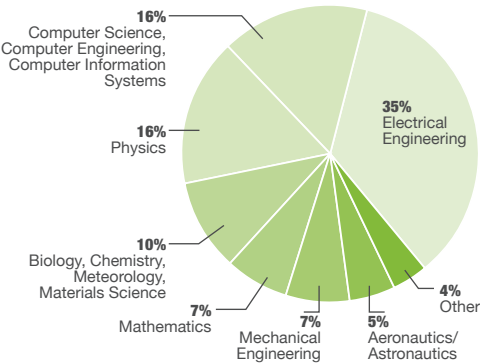
## **Professional Development**

Lincoln Laboratory's commitment to the professional development of its staff is founded on the recognition that the Laboratory's extensive research and development contributions are made possible through the staff's continuing excellence and accomplishments.

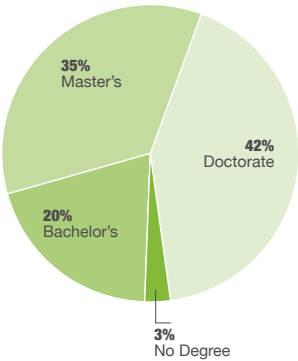
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# Profile of Professional Technical Staff

## Academic Discipline



## Academic Degree



To encourage professional development, the Laboratory supports a variety of opportunities for employees:

- Tuition assistance program
- The competitive Lincoln Scholars Program to enable the pursuit of advanced degrees on a full-time basis
- Distance learning programs with Carnegie Mellon University and Pennsylvania State University
- In-house Technical Education Program
- In-house training in computer applications; seminars on topics in management
- Collaborative technical seminar series with MIT, Northeastern University, and other universities
- Technical seminars on innovative work, given weekly by staff members

Support for professional activities is strong. The Laboratory encourages staff to publish in technical journals, attend conferences, and participate in activities of their professional societies. In addition, interdisciplinary projects allow staff to grow professionally.

The onsite library offers a highly focused, comprehensive collection of technical books, reports, and electronic journals and databases in all Laboratory technology areas. In addition, the resources of the main MIT library system are available to staff.

## **Diversity and Inclusion**

Lincoln Laboratory is committed to diversity and inclusion in the workforce. The Laboratory recognizes that its continuing success is achieved through the appreciation and support of the diverse talents, ideas, cultures, and experiences of its employees.

The Diversity and Inclusion Office seeks to

- Recruit the best technical and support talent from the diverse national pool of candidates



- Foster a work environment built on trust and inclusion
- Develop all aspects of the Laboratory community through improved mentorship, networking, and staff development
- Adapt training and development approaches to ensure the professional growth of the Laboratory's diverse staff
- Build external and internal relationships that align with the Laboratory's diversity initiatives

## Diversity and Inclusion Initiatives

- Recruiting efforts and outreach to minority student organizations have been enhanced to increase the hiring of highly qualified women and minority technical professionals.
- Networking groups help new employees transition to the Laboratory, promote professional development, and encourage involvement in the community. The Lincoln Laboratory New Employee Network, Technical Women's Network, Hispanic and Latino Network, Veterans Network, Lincoln Employees' African American Network, and Out Professional Employee Network are fostering an inclusive environment.
- Lincoln Laboratory's four formal mentorship programs complement efforts to create an inclusive community. The New Employee Guides program focuses on acquainting employees with their groups, divisions, or departments during their early months at the Laboratory. Staff can later choose to participate in more specialized mentoring programs:
  - Early Career Mentoring provides one-on-one mentorship to help technical and administrative professionals with early career development.
  - Circle Mentoring small discussion groups are led by experienced employees and address topics relevant to professional growth.
  - By partnering a new assistant group leader with an experienced group leader, the New Assistant Group Leader Mentoring helps technical staff members transition into their new responsibilities

## **Work-Life Balance**

Lincoln Laboratory recognizes that a balance between work and personal life is essential for employees' well being. The Laboratory offers a number of services to assist employees in maintaining such a balance, as well as offering flexible work schedules, part-time employment, and telecommuting opportunities.

## **Child Care**

The Lincoln Laboratory Childcare Center in Lexington is just 1.3 miles from the Laboratory and provides developmentally based infant, toddler, and preschool programs for children from 8 weeks to 5–6 years old. The center is one of the five Technology Childcare Centers managed by Bright Horizons and overseen by the MIT Work-Life Center.

## **Health and Wellness Center**

The Health and Wellness Center houses a medical facility operated by MIT Medical and a fitness center. The medical center offers primary care services for members of the MIT Health Plan and brief medical assistance for employees. The Fitness Center, which all employees are eligible to join, is run by the MIT Athletic Department.

## **MIT Activities Committee (MITAC)**

MITAC promotes the enjoyment of Boston-area cultural and recreational activities by offering opportunities for or discount tickets to everything from hayrides to NYC shopping sprees to ski getaways, as well as to various sporting events, exhibitions, theater, and musical performances.

## **MIT Federal Credit Union**

All Lincoln Laboratory employees may become members of the MIT Federal Credit Union, which offers savings plans and low-interest loans.

## **Professional and Community Enhancement (PACE) Committee**

The PACE Committee assists Lincoln Laboratory's director to help ensure a productive workplace and a supportive and diverse community. The PACE Committee helps with decisions about the child-care facility, professional development opportunities, mentoring, and other workplace concerns.

## **Commuter Services**

Lincoln Laboratory encourages sharing transportation to work and using public transportation through several programs that offer employees assistance with commuting:

- Hitch-a-Ride Matching Service
- Rideshare Program
- Guaranteed Ride Home Program
- MBTA Pass Program

## **Brown Bag Seminars**

The Human Resources Department at Lincoln Laboratory offers a wide range of seminars, free of charge to employees. Held about once a month and called Brown Bag Seminars because they are advertised as "bring your lunch" events, the seminars are presented by community experts on topics such as parenting, communication, elder care, and managing finances.

## **The Ombudspersons Program**

The ombudspersons are employees who have been appointed by the Laboratory's director to help resolve employee concerns. Ombudspersons provide informal, impartial assistance that may facilitate fair and equitable resolutions of problems or disputes. Ombudspersons do not represent anyone; they act as neutral parties and respect the rights of privacy of individuals they are helping.



## Facilities and Field Sites

### Facilities

#### Microelectronics Laboratory

The Lincoln Laboratory Microelectronics Laboratory is a state-of-the-art semiconductor research and fabrication facility supporting a wide range of Lincoln Laboratory programs. The 70,000 sq ft facility has 8100 sq ft of class-10 and 10,000 sq ft of class-100 cleanroom areas.

The equipment set in this laboratory is continually updated and includes a production-class complementary metal-oxide semiconductor (CMOS) toolset with angled ion-implantation, cluster-metallization, and dry-etch equipment; chemical-mechanical planarization equipment; and rapid thermal processing and advanced lithography capabilities. A molecular-beam epitaxy system is used to provide high sensitivity and highly stable back-illuminated devices in the ultraviolet and extreme ultraviolet ranges. In addition, the Microelectronics Laboratory supports advanced packaging with a precision multichip module technology and an advanced three-dimensional circuit-stacking technology.

#### Lincoln Space Surveillance Complex

The Lincoln Space Surveillance Complex in Westford, Massachusetts, has played a key role in space situational awareness and the Laboratory's overall space surveillance mission. The site comprises three major radars—Millstone Deep-Space Tracking Radar (L band), Haystack Ultrawideband Satellite Imaging Radar (HUSIR) (X and W bands), and the Haystack Auxiliary Radar (Ku band).

The Millstone Hill Radar is used for tracking space vehicles and space debris. Like Millstone, HUSIR is a contributing sensor to the U.S. Space Surveillance Network, collecting radar data on space objects.

### **RF System Test Facility**

The antenna and radar cross-section measurements facility, constructed at Lincoln Laboratory on Hanscom Air Force Base, was designed with a rapid prototyping focus for radar and communication systems development.

There are five indoor test ranges: a small shielded chamber for electromagnetic induction measurements; two small utility ranges consisting of a tapered anechoic chamber and a millimeter-wave anechoic chamber; a compact range; and a systems development chamber that works in conjunction with an instrumentation laboratory. In addition to the chambers, multipurpose signal generation, data acquisition, and control and recording instrumentation in a systems integration laboratory provide a supporting role in the rapid prototyping of RF systems. A high-bay staging area and machine shop support the development of rapid prototype antennas. Antennas and subsystems are tested in an integrated RF system in the compact range and system test chambers.

### **Rapid Hardware Integration Facility**

Lincoln Laboratory's 3900-square-foot hardware-integration facility supports the rapid integration and fielding of specialized systems. It was designed to accommodate an increased emphasis on rapid prototyping projects by providing the appropriate tools, collaborative environment, and required infrastructure. This facility, spread over two floors, maximizes collaboration between team members and minimizes the time to iterate through the design-build-test cycle by collocating spaces for fabrication and integration. The facility is divided into areas for system integration, electronic assembly, additive manufacturing (3D printing),

and conventional machining. It can accommodate the development of about five to eight systems, all with concept-to-system delivery timelines of less than 12 months.

### **Flight Test Facility**

The Lincoln Laboratory Flight Test Facility provides airborne platforms in support of research and development programs. The facility enables researchers to validate airborne systems with actual field-collected data. Research aircraft are flown, maintained, and managed by a professional staff of pilots, certified maintenance technicians, and administrative personnel. All flight operations are conducted using procedures and equipment that meet or exceed all Federal Aviation Administration (FAA) requirements.

### **Lincoln Laboratory Grid**

The Lincoln Laboratory Grid is an interactive, on-demand parallel computing system that uses a large computing cluster to enable Laboratory researchers to augment the processing power of desktop systems with high-performance computational cluster nodes to process large sets of sensor data, create high-fidelity simulations, and develop entirely new algorithms.

### **Optical Systems Test Facility**

The Optical Systems Test Facility was established at Lincoln Laboratory to support a broad scope of program areas, encompassing tactical ground-based sensors through strategic space-based sensors.

The Optical Systems Test Facility comprises several separate ranges developed as a coordinated set of test sites at the Laboratory. Currently, four separate ranges are housed in the facility: an active range (Laser Radar Test Facility), a passive range (Seeker Experimental System), an aerosol range (Standoff Aerosol Active Signature Testbed), and an optical material measurements range.

### **Environmental Test Laboratory**

The Environmental Test Laboratory is one of the Engineering Division's facilities used by coalition project teams for demonstrating novel ground-based, sea-based, airborne, and space-based systems. This laboratory supports both small rapid development efforts and large systems development. The laboratory's vibration systems are used for sinusoidal, random vibration, and shock-response testing. The vacuum systems test high-altitude and satellite hardware. Thermal chambers test hardware limits at hot and cold temperatures.

### **Polymer Laboratory**

The Engineering Division's Polymer Laboratory supports Lincoln Laboratory's prototype building efforts. It is used for composite assemblies, adhesives and elastomeric molding, priming and painting, circuit board conformal coating, material property testing, heat treatment, and vacuum bagging.

### **Netcentric and Cyber Center**

The Netcentric and Cyber Center, used by researchers in multiple mission areas, is a facility that enables rapid deployment and demonstrations of network-centric and cyber architectures.

### **Lincoln Research Network Operations Center**

The Lincoln Research Network Operations Center (LRNOC) is used to develop prototype cyber analysis tools by processing the Laboratory's own operational network traffic, security system alerts, information technology system logs, and configuration data. The LRNOC serves as a test bed for exploring and evaluating new techniques prior to prototype deployment on Department of Defense networks.

## **Air Traffic Management Laboratory**

The Air Traffic Management (ATM) Laboratory is used to test and demonstrate a variety of air traffic surveillance, aviation weather, and decision support systems. Systems currently integrated in the ATM Lab include the Corridor Integrated Weather System, the Enhanced Regional Situation Awareness system, a Runway Status Lights system, and the Enhanced Traffic Management System. Each of these systems is connected to live data from various field sites and national systems.

## **Integrated Weather and Air Traffic Test Facility**

The Integrated Weather and Air Traffic Test Facility supports the Laboratory's work on improvements in flight safety and efficiency. Among the facility's resources is a real-time operations center for various live prototype tests, including tests of the Federal Aviation Administration's (FAA) Corridor Integrated Weather System. The facility is also connected to the FAA's Enhanced Traffic Management System, which supplies flight track information for all aircraft in the country. The facility's computer room houses a 200+-node computer cluster and 300 terabytes of data storage used to keep the real-time systems running, as well as a large complement of computers used for analysis.

## **Decision Support Laboratories**

The Decision Support Laboratories provide development, evaluation, and visualization capabilities for decision support activities in a number of areas, including intelligence, surveillance, and reconnaissance; integrated sensing; space situational awareness; air traffic management; and air and missile defense.

## **Field Sites**

**Reagan Test Site, Kwajalein Atoll, Marshall Islands**

Lincoln Laboratory serves as the scientific advisor to the Reagan Test Site at the U.S. Army Kwajalein Atoll



installation located about 2500 miles WSW of Hawaii. Twenty staff members work at this site, serving two- to three-year tours of duty. The site's radars and optical and telemetry sensors support ballistic missile defense testing and space surveillance. The Laboratory also supports upgrades to the command-and-control infrastructure of the range to include applications of real-time discrimination and decision aids developed as a result of research at the Laboratory.

#### **Experimental Test Site, White Sands Missile Range, New Mexico**

The Experimental Test Site (ETS) is an electro-optical test facility located on the grounds of the White Sands Missile Range in Socorro, New Mexico. Situated next to the U.S. Air Force's Ground-based Electro-Optical Deep Space Surveillance field site, the ETS is operated by the Laboratory for the Air Force. The principal mission of the ETS is the development, evaluation, and transfer of advanced electro-optical space surveillance technologies. It is a national resource that supports measurements and operational surveillance tasking for programs such as those involving near-Earth and deep-space objects.

#### **Pacific Missile Range Facility, Kauai, Hawaii**

The Pacific Missile Range Facility (PMRF) on the Hawaiian island of Kauai is one of the Pacific ranges supporting experimental and developmental testing of the Ballistic Missile Defense System. Lincoln Laboratory personnel at PMRF provide technical advice, consultation, and analysis support as requested by government leadership at the Range. The Laboratory has provided significant inputs into sensor designs and implementations for PMRF.

#### **Field Offices**

- Crystal City Field Site, Arlington, Virginia
- Aviation Liaison Office, Washington, D.C.
- Colorado Springs Field Site, Colorado Springs, Colorado

- Ground-based Electro-Optical Deep Space Surveillance and Space Surveillance Telescope Field Sites, Socorro, New Mexico
- Huntsville Field Site, Huntsville, Alabama
- Nevada Field Site, Henderson, Nevada
- Space and Missile Systems Center Liaison Office, El Segundo, California
- Vandenberg Air Force Base Field Office, Vandenberg Air Force Base, California



## Technology Transfer

Lincoln Laboratory has a long history of promoting technology transfer to the defense and the civil sectors. Many technologies initially developed to meet defense requirements have been adapted for commercial use. For example, under the U.S. Air Force's Semi-Automatic Ground Environment air defense program of the 1950s, Lincoln Laboratory's expansion of the capabilities of MIT's Whirlwind computer, the first to operate in real time and to use video displays for output, led to the development of the IBM 704 business computer. Subsequent developments led to minicomputers in the 1960s.

Lincoln Laboratory's focus on adapting and demonstrating new, advanced capabilities to enhance existing systems results in important technology transfer opportunities. A common strategy for achieving transition is to share the "architectural recipe" and work with commercial component and subsystem suppliers to assure that technology advances demonstrated by the Laboratory can be duplicated by industry.

One reason for the Laboratory's success in transferring technology is its participation in sponsor-supported programs with industry. Such programs complement the Laboratory's work on developing and prototyping new device concepts.

Transfer of technology is accomplished in several ways as circumstances allow:

- Direct transfer of designs and specifications
- Funded industrial development of Lincoln Laboratory-designed subsystems

- One-on-one technical meetings
- Open technical seminars
- Industry-wide workshops in areas of the Laboratory's expertise
- Establishment of advanced test bed systems against which industry can develop systems and verify performance

## **Spin-off Companies**

One measure of the Laboratory's contribution to the nation's economy is its success in transferring technology to spin-off companies. Since the Laboratory's inception, 98 high-technology companies have evolved from the Laboratory's technology development. These companies' services and products range from multimedia software services to advanced semiconductor lithography. The spin-off companies are large organizations such as MITRE, a not-for-profit research and development corporation, and small businesses such as TeK Associates, a software consulting firm, and are found not only in Massachusetts but also in states beyond.

### **Notable Spin-off Companies**

MITRE Corporation

Digital Equipment Corporation

American Power Conversion Corporation

Applicon, Inc.

Arcon Corporation

Axsun Technologies, Inc.

Centocor, Inc.

Computer Corporation of America

HighPoint Systems, Inc.

Innovative Biosensors, Inc.

Kenet, Inc.

Kopin Corporation

Lasertron, Inc.

LightLab Imaging LLC

Metric Systems Corporation  
Photon, Inc.  
TeK Associates  
Saperix Technologies  
Telenet Communications, Inc.  
TeraDiode  
Tyco Laboratories, Inc.  
XonTech, Inc.

## **Patents**

Lincoln Laboratory has contributed to the nation's and the world's technical knowledge base through the U.S. patents issued for its technologies. Laboratory technical innovations licensed to industry have enabled many commercial-sector applications, from air traffic management systems to semiconductor processing to biological-agent sensors. In the last 63 years, approximately 780 U.S. patents have been issued for advancements and inventions developed by Lincoln Laboratory researchers.

## **Subcontracts with Business and Universities**

Lincoln Laboratory contracts with companies to design and fabricate developmental hardware and material. The technical expertise developed by companies during the Laboratory-funded proof-of-concept phase is carried forward to the production phase. Often, this prototype work results in business for companies who later produce the hardware/material commercially. The Laboratory also contracts with universities for basic and applied research; the collaborations forged through these partnerships also promote the exchange of technology and knowledge.

## **Cooperative Research & Development Agreements and the Small Business Technology Transfer Program**

Lincoln Laboratory engages in a limited number of Cooperative Research and Development Agreements (CRADAs) and Small Business Technology Transfer

Program (STTR) arrangements. Both these arrangements are mechanisms for increasing interactions with industry, thus promoting mutual knowledge exchange and technology transfer, and benefiting both partners by providing them with R&D they might not readily accomplish within their budgets and facilities.

Technologies investigated through these arrangements are those consistent with the Laboratory's defined mission areas and are frequently ones that enable advancements to processes and devices.

### **Small Business Office**

Lincoln Laboratory has a strong program designed to afford small business concerns, as defined by the U.S. government, the maximum opportunity to compete for purchase orders. The Small Business Office (SBO) ensures that small business, veteran-owned small business, service-disabled veteran-owned small business, HUBZone small business, small disadvantaged business, and woman-owned small business concerns, as well as historically black colleges or universities or minority institutions, are given the maximum possible opportunity to participate in Laboratory acquisitions.

The Lincoln Laboratory SBO can be reached at SBLO@ll.mit.edu or 781-981-SBLO (781-981-7256).

*For more information on the SBO, visit the web at <http://www.ll.mit.edu/about/SmallBusiness/smallbusiness.html>.*



## **Collaborations with MIT Campus and Other Universities**

### **Research**

Research collaborations foster knowledge exchange between universities and Lincoln Laboratory, strengthen the research conducted at all partnering institutions, and enhance the professional development of participating scientists and engineers. Multiple mechanisms support these collaborations; some of them are highlighted here.

#### **MIT Lincoln Laboratory Beaver Works Center**

The Beaver Works Center, a joint venture between Lincoln Laboratory and the MIT School of Engineering, was established as an incubator for research and innovation. The center facilitates project-based learning, a hallmark of an MIT education, and leverages the expertise of MIT faculty, students, and researchers, and Lincoln Laboratory staff to broaden research and educational partnerships. By encouraging collaborative projects, Beaver Works strengthens the potential of both institutions to make an impact on pressing global problems.

The new center provides facilities for various educational activities: areas for collaborative brainstorming; workshops and tools for the fabrication of prototype systems; and space for classroom-style instruction. Beaver Works supports student involvement in a broad range of research and educational pursuits, including two-semester, course-based capstone projects; joint and individual research initiatives; and Undergraduate Research Opportunities Program internships.

## **Integrated Quantum Initiative**

The Integrated Quantum Initiative (IQI) is exploring ways for Lincoln Laboratory and MIT campus researchers to better leverage their unique expertise and resources to develop quantum information science solutions for sensing, communication, and computation. The program is centered around supporting graduate students who work part time at the Laboratory on projects such as the development of magnetic sensors based on nitrogen vacancies in diamond and the investigation of quantum communication protocols. Additionally, IQI participants are looking at ways to support large-scale experiments and scalable quantum systems; for example, a dedicated fiber link for quantum communication experiments between the Laboratory and MIT campus was recently established. The initiative is focusing on applications that are of interest to the Department of Defense and that have the potential to advance the Laboratory's core mission areas.

## **Advanced Concepts Committee**

The Lincoln Laboratory Advanced Concepts Committee (ACC) supports the development of innovative concepts that address important technical problems of national interest. Collaborative efforts between Lincoln Laboratory and research universities are encouraged. The ACC provides seed funding, as well as technical and programmatic support, to investigators with new technology ideas.

## **New Technology Initiatives Program**

The New Technology Initiatives Program (NTIP) supports initiatives that significantly extend the application of new technologies and approaches to our nation's current and future problems. The NTIP works with the Laboratory community and outside resources to identify user needs, capability drivers, and enabling technologies.



### MIT Independent Activities Period Courses

Lincoln Laboratory technical staff develop and lead activities offered during MIT's Independent Activities Period (IAP), a four-week term spanning the January semester break. Under the IAP program, for-credit classes are available for registered MIT students, and non-credit activities are open to all members of the MIT community. IAP offerings range from academic seminars to hands-on engineering projects to artistic pursuits. The activities are, as the IAP website states, "distinguished by their variety, innovative spirit, and fusion of fun and learning." Lincoln Laboratory staff have offered courses in radar design, robotics, and imaging technologies.

### MIT Professional Education—Short Programs

Lincoln Laboratory is collaborating on courses offered through MIT's Professional Education Short Programs. Short Programs usually run during the summer and bring participants from industry, government, and business to the campus for intensive, week-long courses designed to expand participants' familiarity with emerging technologies. Through this recent partnership, technical staff members from the Laboratory have co-led courses on radar and laser radar design.

### Technical Seminar Series

Members of the technical staff at Lincoln Laboratory present seminars to interested college and university groups. The 62 currently available seminars from which interested university groups can choose include ones in air traffic control, solid-state devices and materials, communications systems, and space control technology.

*Visit the web at <http://www.ll.mit.edu/college/techseminars.html> to see a complete list of available seminars.*

## **Advanced Education**

### **Military Fellows Programs**

Lincoln Laboratory provides fellowships to active-duty U.S. military officers who are enrolled in a graduate school program, often at MIT, or are completing requirements for advanced education at Senior Service Schools or the U.S. Army's Training with Industry (TWI) program. For graduate students, the military fellowships cover tuition and fees, and require that the students perform thesis research at Lincoln Laboratory. Officers enrolled in a Service School program do research at the Laboratory while taking courses in national security management at MIT. Officers in the TWI program work full time in a Lincoln Laboratory group that specializes in areas that complement the officers' careers.

*For more information on the Military Fellows Programs, visit the web at <http://www.ll.mit.edu/college/fellowsprogram.html>.*

### **MIT Undergraduate Research Opportunities Program**

Lincoln Laboratory is one of the centers with which undergraduates may partner under MIT's Undergraduate Research Opportunities Program (UROP). UROP cultivates research partnerships between MIT undergraduates and faculty, offering students the chance to work on cutting-edge research and participate in each phase of standard research activity.

### **MIT Undergraduate Practice Opportunities Program**

Lincoln Laboratory participates in MIT's Undergraduate Practice Opportunities Program (UPOP). This full-year program for MIT sophomores is an introduction to the workplace skills that complement students' academic training. An important facet of the program is a 10- to 12-week summer internship in industry, government, or a nonprofit institution. As a UPOP partner, the Laboratory offers a limited number of such internships.

### **MIT VI-A Master of Engineering Thesis Program**

Lincoln Laboratory is a partner of MIT's Department of Electrical Engineering and Computer Science VI-A Master of Engineering Thesis Program, which matches industry mentors with undergraduate students. Students in the VI-A program spend two summers as paid interns, participating in projects related to their fields. Then, the students move on to developing their master of engineering theses under the supervision of both Laboratory engineers and MIT faculty.

### **MIT Research Assistants**

As part of the research collaboration between MIT campus and Lincoln Laboratory, MIT graduate students are supported as research assistants while working on Laboratory programs.

### **University Cooperative Education Program**

Technical groups at Lincoln Laboratory employ students from MIT, Northeastern University, and other area colleges as co-ops working full time with mentors during the summer or work/study semesters and part time during academic terms.

### **Summer Research Program**

Lincoln Laboratory offers undergraduate and graduate students the opportunity to gain hands-on experience in a leading-edge research environment. Program participants contribute to projects and gain experience that complements their courses of study. Each summer, the Laboratory hires, on average, approximately 180 paid interns from top universities.

### **WPI Major Qualifying Project Program**

Lincoln Laboratory collaborates with Worcester Polytechnic Institute (WPI) in its Major Qualifying Project (MQP) program, which requires students to

complete an undergraduate project equivalent to a senior thesis. Students participating in the program spend nine weeks during the fall term working on their projects full time at Lincoln Laboratory.

### **Undergraduate Diversity Awards**

Lincoln Laboratory established the Undergraduate Diversity Awards to expand opportunities for women and minorities pursuing bachelor's degrees in engineering and science. The award, as determined by the recipient's college, is typically in the form of tuition assistance, support for technical paper presentations, or funds for independent research projects.

*For more information on student programs, visit the web at <http://www.ll.mit.edu/college/studentprograms.html>.*

### **Graduate Fellowship Program**

Lincoln Laboratory offers a limited number of graduate fellowships to science and engineering students pursuing MS or PhD degrees at partner universities. The fellowship program awards funds to support a Fellow's stipend, supplement a graduate assistantship, or subsidize other direct research expenses during the final phases of students' thesis research.



## **Workshops and Technical Education**

Lincoln Laboratory hosts annual conferences, workshops, and seminars that bring together members of technical and defense communities to share advancements and ideas. These events foster a continuing dialogue that enhances technology development and provides direction for future research.

### **Workshops at Lincoln Laboratory**

#### **A2/AD Systems and Technology Workshop**

The workshop provides an overview of antiaccess/area denial (A2/AD) challenges facing the Department of Defense and the intelligence communities. Laboratory presenters and invited guest speakers examine systems, tactics, and technologies to counter emerging A2/AD threats. Topics under discussion may include base and fleet defense, contested airspace, space control, cyber warfare, communications, and intelligence, surveillance, and reconnaissance (ISR) architectures and systems,

#### **Advanced Research and Technology Symposium**

The symposium is designed to showcase innovative technologies developed at Lincoln Laboratory and in partnership with MIT researchers. Themes each year reflect current and evolving areas of research and development. The symposium consists of short talks, interactive poster sessions, and keynote lectures in each of the theme areas.

### **Advanced Technology for National Security Workshop**

This forum helps architects of government systems to understand how new technology can have a profound impact on future systems critical to national security. Government technology developers, industry partners, and system integrators have the opportunity to share new ideas in an interactive meeting.

### **Air and Missile Defense Technology Workshop**

This workshop provides an overview of current developments in areas such as air and missile defense elements, air and missile defense architectures, advanced concepts and technology, test infrastructures, and intelligence capabilities.

### **Air Vehicle Survivability Workshop**

The workshop presents the air vehicle survivability community with an update on recent analysis and testing, and provides a forum for relevant briefings from the community.

### **Cyber and Netcentric Workshop**

The focus of this workshop is cyber security and netcentric operations. The workshop provides the user, acquisition, research, and developer communities with discussions on lessons learned, current trends, technical challenges, and the road ahead.

### **Defense Technology Seminar**

This weeklong seminar focuses on technologies for the warfighter. Major sessions are devoted to air defense and space situational awareness. New national security challenges in counterinsurgency warfare, homeland security, and network-centric operations are part of the discussion.

### **Human Language Technology and Applications Workshop**

Users and developers of human language technologies come together to share ideas on technical challenges and lessons learned from applying human language technology to U.S. government applications. Workshop topics may include robust content extraction from speech; text information extraction; machine translation and cross-language information extraction on real-world data; deep neural nets and active learning; and visual analytics for large volumes on language data.

### **Intelligence, Surveillance, and Reconnaissance Workshop**

This national forum is an opportunity for system developers and operational users to present and discuss technology developments and new system concepts in intelligence, surveillance, and reconnaissance.

### **Lincoln Laboratory Communications Workshop**

The two-day workshop offers users, developers, and researchers of Department of Defense (DoD) communication systems the opportunity to exchange ideas on current trends and technical challenges in developing future DoD communication architectures.

### **Mechanical Engineering Technology Symposium**

The symposium is an opportunity for engineers and system developers to discuss developments in advanced electronic packaging; mechanical, optical, and aeronautical modeling; and advanced materials.

### **Space Control Conference**

This longstanding conference brings together the space control community to address current capabilities, future needs, and technology development.

Attendance at workshops and seminars at Lincoln Laboratory is by invitation; participants must complete and submit the Laboratory's security authorization form.

*For more information on workshops, seminars, and conferences held at Lincoln Laboratory, visit the web at <http://www.ll.mit.edu/workshops/index.html>.*

## **Offsite Workshops**

The Laboratory also coordinates offsite workshops with partnering organizations. Laboratory involvement may be co-chairmanship of events, technical leadership of sessions, or co-sponsorship.

### **Air Traffic Control Workshop**

The workshop, held at the Federal Aviation Administration's headquarters in Washington, D.C., brings together speakers from Lincoln Laboratory, government, industry, academia, and federally funded research and development centers to present research on advanced concepts, technology, and systems development supporting the Next Generation Air Transportation System.

### **Homeland Protection Workshop Series**

This series' workshops cover three topics: chemical, biological, and explosive defense; air, borders, and maritime security; and incident response and disaster management. Attendees at the sessions held in Reston, Va., learn about homeland security and defense innovations through presentations given by speakers from the senior levels of government and Lincoln Laboratory.

### **IEEE High Performance Extreme Computing Conference**

IEEE hosts the High Performance Extreme Computing Conference that is traditionally held in September in Waltham, Mass. Lincoln Laboratory serves as the technical organizer for this forum that fosters dialog among members of the computing community.



## **IEEE International Symposium on Technologies for Homeland Security**

This symposium, hosted by IEEE and held in the Greater Boston area, brings together innovators from academia, industry, Homeland Security Centers of Excellence, and government to discuss novel concepts for protecting the nation and to review experimental results of new programs.

## **IEEE Silicon-on-Insulator (SOI)-3D-Subthreshold Microelectronics Technology Unified Conference**

IEEE hosts this new unified conference that allows researchers to review the most up-to-date trends in complementary metal-oxide semiconductor (CMOS) technology. Lincoln Laboratory serves on the technical committees organizing this conference, which is held in a different U.S. city each year.

## **Technical Education Courses—Invited**

Lincoln Laboratory presents technical courses designed for military personnel and government-employed civilians. These by-invitation courses typically run from three to five days and include seminars and tours at the Laboratory's specialized facilities.

## **Ballistic Missile Defense (BMD) Technology**

The BMD Technology course provides an understanding of BMD systems concepts and technologies to military officers and DoD civilians involved in BMD systems development and acquisition.

## **Introduction to Intelligence, Surveillance, and Reconnaissance (ISR) Systems and Technology**

This course introduces DoD civilians and military officers to the fundamentals of ISR systems and platforms, and data processing, exploitation, and dissemination. The three-day course was developed in response to the critical role ISR plays in military conflicts abroad and homeland defense.

## Introduction to Radar Systems

This course has been developed to provide an understanding of radar system concepts and technologies to military officers and DoD civilians involved in radar system development and acquisition.

## Networking and Communications

Through lectures, demonstrations, and tours, the course provides fundamentals and advanced concepts of networks and communications systems for military officers and DoD civilians.

## Technical Education—Online Courses

Lincoln Laboratory online courses consist of video lectures and accompanying PowerPoint lecture notes and charts.

## Adaptive Antennas and Phased Arrays

The 16 lectures in this course cover both theory and experiments; lectures 1 to 7 discuss adaptive antennas, and the remaining nine lectures are on phased arrays.

## Introduction to Radar Systems

This ten-lecture video course was excerpted from the three-day radar course listed above.

*To learn more about the video courses, visit the web at <http://www.ll.mit.edu/workshops/education/videocourses/>.*



# Community Outreach

Lincoln Laboratory Community Outreach (LLCO) encourages community service and promotes K–12 education through a variety of initiatives, some in cooperation with the MIT Public Service Center.

## Educational Outreach

Lincoln Laboratory Educational Outreach by the Numbers

<b>30</b>	<b>300</b>	<b>5250</b>	<b>10,000+</b>
K–12 STEM programs	Scientists and engineers volunteering as mentors, speakers, or tour guides	Hours per year supporting STEM programs	Students seeing STEM demonstrations at Lincoln Laboratory and in area schools

**Lincoln Laboratory Radar Introduction for Student Engineers**  
Lincoln Laboratory Radar Introduction for Student Engineers (LLRISE) is a two-week residential program for high-school students entering their senior year. The program includes instructional sessions on the basics of radar systems and radar imaging; workshops to build radar systems that can perform range-Doppler imaging; and hands-on exercises using the radars built in the workshops. During the two weeks, students are housed in a dormitory at MIT and attend sessions on campus to learn more about the college application and financial aid processes.

## **Science on Saturday**

Laboratory technical staff give lively, interactive demonstrations for local-area students, their parents, and teachers. These popular events have ranged from hands-on engineering activities, such as building gumdrop towers, to demonstrations on the “magic” of chemistry, lasers and optics, and computers. Annually, 3500 people attend these sessions.

## **Classroom Presentations**

Lincoln Laboratory technical staff members visit local area schools to give presentations and conduct hands-on activities. Each year, approximately 7000 students in grades K to 12 enjoy presentations on topics such as cryogenics, archaeology, fossils, aerodynamics, chemistry, and physics.

## **Robotics Outreach at Lincoln Laboratory (ROLL)**

ROLL takes advantage of the current popularity of robotics to interest K–12 students in science and technology. ROLL is sponsoring teams in the FIRST (For Inspiration and Recognition of Science and Technology) competitions, hosting robotics workshops at the Laboratory, and providing technical mentors to local-area schools and groups. Each year, more than 90 students participate on 12 Laboratory-mentored teams.

## **CyberPatriot**

Lincoln Laboratory sponsors and coaches a team that participates in the Air Force Association’s CyberPatriot competitions. Under this national program, teams of high-school students are challenged to detect and clear cyber vulnerabilities on virtual machines. Teams who detect the most vulnerabilities advance through three rounds of these “cyber games” to reach the National Championship round in Washington, D.C.

### **MIT Office of Engineering Outreach Programs**

Lincoln Laboratory is collaborating with MIT's Office of Engineering Outreach Programs (OEOP), which runs four enrichment programs for either middle- or high-school students. These programs are aimed at encouraging students, particularly in underserved populations, to pursue careers in science, technology, engineering, and math.

### **Armed Forces Communications and Electronics Association (AFCEA) International Program**

Lincoln Laboratory participates in an AFCEA educational program by providing summer employment internships for graduating high-school seniors interested in science, technology, math, and engineering.

### **High School Internship Programs**

Lincoln Laboratory has established learning affiliations with Minuteman Regional High School and Shawsheen Technical Vocational High School. Under these programs, Lincoln Laboratory annually will make available one-semester internships for high-school seniors from the schools.

### **Ceres Connection**

Since 2003, Lincoln Laboratory, in partnership with the Society for Science & the Public, has promoted science education through its Ceres Connection program, which names minor planets in honor of students in fifth through twelfth grades and their teachers. Each year approximately 250 students and teachers are selected through the science competitions sponsored by the Society for Science & the Public.

### **Wow! That's Engineering!®**

The Society of Women Engineers (SWE) promotes education in science, technology, engineering, and math through its Wow! That's Engineering! events run

by individual SWE chapters. Volunteers from Lincoln Laboratory’s technical staff and from the Boston chapter of SWE direct all-day, engineering immersion workshops for 100 middle-school-age girls.

**Community Service and Giving**

**Lincoln Laboratory Giving by the Numbers**

<b>25</b>	Charities benefited from giving programs
<b>200</b>	“Care” packages sent annually to deployed troops
<b>500</b>	Toys donated to Toys for Tots drive
<b>500</b>	Coats collected in the Coats for Kids drive
<b>\$1200</b>	Raised at a used-book sale to support educational programs and Community Giving at MIT
<b>\$7420</b>	Raised for the Multiple Sclerosis Society in the Bike & Hike the Berkshires fundraiser
<b>\$36,562</b>	Raised at the annual Alzheimer’s Association Memory Walk

**MIT LL Alzheimer’s Awareness and Outreach**

This informal volunteer group provides support and useful information to fellow employees who are experiencing the significant impact Alzheimer’s disease has on individuals and families. They also raise funds to benefit the Massachusetts/New Hampshire chapter of the Alzheimer’s Association, which supports research into the disease, patient care, and awareness programs. The Laboratory teams that participate in the summer Alzheimer’s Breakthrough (bicycle) Ride and the September Walk to End Alzheimer’s are consistently among the region’s most successful fundraisers.

### **Food and Clothing Drives**

The LLCO runs food and clothing drives that support local charities. Food items are distributed to food pantries in the area, and clothing is given to a number of shelters and the Salvation Army.

### **Support Our Troops**

Lincoln Laboratory runs an ongoing campaign of support for deployed U.S. troops. Donations of food, toiletries, books, and games are collected daily, boxed by volunteers, and mailed weekly. In addition, the program has sent care packages to the children of villages in Afghanistan and Iraq where U.S. troops are serving.

### **Bike and Hike the Berkshires**

The annual fall Bike and Hike the Berkshires event benefits the National Multiple Sclerosis Society Central New England chapter. Teams of bicyclists and walkers gather pledges for completing one of three distance courses up Mount Greylock in western Massachusetts.

### **Used-Book Drive and Sale**

Proceeds from the sale of books and media donated by Laboratory employees are given to Community Giving at MIT to support local charities and to Lincoln Laboratory Community Outreach to fund future educational outreach programs.

### **The Holiday Giving Tree**

During the winter holiday season, Laboratory employees donate gifts to area residents affected by the economic downturn. The gifts are distributed by Somebody Cares, a national charitable organization with affiliates in the region.

## Marshallese Outreach

The Marshallese Outreach program was developed to enrich educational and life experiences of the people of the Marshall Islands, particularly those from Kwajalein Atoll, where Lincoln Laboratory staff work as scientific advisors to the Reagan Test Site located there.

*For more about the educational and community service programs of the LLCO, visit the web at <http://www.ll.mit.edu/outreach/index.html>.*





## Contacts

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<http://www.ll.mit.edu>

### **Human Resources**

Phone: 781-981-7066

College Recruiting Program Administrator

E-mail: [collegerecr@ll.mit.edu](mailto:collegerecr@ll.mit.edu)

Phone: 781-981-2465

### **Communications and Community Outreach Office**

Phone: 781-981-4204

E-mail: [llnews@ll.mit.edu](mailto:llnews@ll.mit.edu)

### **Technology Transfer**

Lincoln Laboratory Technology & Contracts Office

Phone: 781-981-5824

MIT Technology Licensing Office

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